EXHIBIT A

Ellen Rader Smith, OTR, CVE, CPE **ERS**

Licensed Occupational Therapist
Certified Vocational Evaluator
Certified Professional Ergonomist

PO Box 37, Towaco, NJ 07082
Phone & Fax (973) 334-7499
ergoers@optonline.net

November 27, 2013

Mr. Jerry Martillotti, Esq.
Jerry Martillotti & Associates, PC
4221 Ridge Avenue, PO Box 18509
Philadelphia, PA. 19129

ERMOND SANTANNA: ERGONOMIC ASSESSMENT
Rail ID# 683000

Dear Mr. Martillotti:

This Ergonomist was contacted to assess the ergonomic factors inherent in the performance of Mr. Santana's work as a CP Rail Conductor and how this relates to his bilateral knee degenerative joint disease. Mr. Santana is a 56-year old man who worked for the railroad (CP Rail and its predecessors) for 34 years, from 1977- December 2011 when he went out on railroad occupational disability.

In preparing this report, this Ergonomic expert had the opportunity to review the following documents and materials which your office provided:

1) Medical reports: Scranton Orthopedics/Dr. Malloy (11/16/11,12/19/11, 01/12/12 and 04/12/12), Haley Family Practice/Dr. Haley (1/19/08, 5/4/09, 8/3/10, 11/4/10, 7/11/11, 8/14/11, 10/13/11, 10/27/11, 11/23/11, 3/28/12); Scranton Hematology-Oncology/Dr. Hyzinski (03/09/12) and Marian Community Hospital/Radiology (10/14/11, 10/20/11)
2) Canadian Pacific Railway Fitness for Duty report (1/3/12) completed by Dr. Haley
3) Complaint filed 6/28/12
4) Plaintiff's Response to Defendant's First Set of Interrogatories

I also reviewed:

5) prior CP Rail documents that were in my possession: Canadian Pacific/CP documents: CP Additional Rules and Safety Instructions, Safety & You and Safety Handbook, Engineering Pre-Test Part A year 2000, Engineering Services #1 Safety and You 2002 and 2003 Participant Guides, Engineering Services Annual Safety Training, Engineering Services Annual Safety Training 2004; Additional Rules and Safety Instructions for Engineering Department Personnel, Track Car Operators, Train Dispatchers and Transportation Supervisors; and Deposition transcripts of Dr. Weames (4/22/10, 7/29/10);
6) Conducted a 1.75-hour telephone interview with Mr. Santanna on October 2, 2013 where he reviewed his usual Conductor job demands; and
7) Relied upon my over 25 years expertise as a Certified Professional Ergonomist; interviews with and site inspections for other Conductors, and the studies and

documents listed in the Endnotes of this report that pertain to the literature on work related musculoskeletal disorders, particularly those affecting the lower extremities.

Brief Medical Overview

Mr. Santanna saw Dr. Haley, his primary care physician, intermittently (08/10 - 03/12) for management of his hypertension, hyperlipidemia, diabetes, and obesity. Dr. Haley first noted osteoarthritis in generalized multiple sites, and skin and subcutaneous tissue disorder in July 2011, and of bilateral knee pain in October 2011[1].

Diagnostic tests showed:

x-ray left knee (10/11): osteoarthritic changes
x-ray right knee (10/11): osteoarthritic changes
Bone scan whole body (10/11): normal, no abnormal activity right knee

Mr. Santanna initially saw Dr. Malloy (11/16/11) for right knee pain, and was given a steroid injection. Dr. Malloy noted that Mr. Santanna had worked for the railroad for 35 years doing heavy and strenuous work duties and his past medical history of hypertension, diabetes, bladder cancer; removal of melanoma left leg and lymph node resection in the groin, without re-occurrence; and a left ankle fracture with ORIF in 1990 from a slip and fall work accident. Dr. Malloy felt Mr. Santanna could work for a period of time but will be very limited because of significant osteoarthritis.

Dr. Malloy (12/11) noted Mr. Santanna's onset of right knee pain in November and more recent of the left knee; that left knee x-rays and MRI showed a posterior medial meniscus tear and Grade III narrowing; and a genu varum deformity of both knees. He provided steroid injections to both knees.

Dr. Malloy (01/12) noted that x-rays and MRI's showed severe degenerative arthritis of both knees and incidental menisci tears. He felt that Mr. Santanna was disabled for work and provided Synvisc injections to both knees. In a Fitness for Duty report, Dr. Malloy (1/3/12) noted permanent work restrictions of no lift/carry 0-10 pounds, bend/stoop 0-6x/hour, push/pull 0-10 pounds and no climbing; and that Mr. Santanna was permanently disabled as a railroad mechanic and conductor[2].

Dr. Hyzinski (03/12) noted that Mr. Santanna had been out of work since December because of his knees and had a lot of pain/swelling at the end of the work shift, more so for the right knee; no recurrent melanoma or urothelial carcinoma; and his severe degenerative arthritis interfered with his ability to work as a railroad conductor.

Dr. Malloy (04/12) noted severe tricompartmental degenerative arthritis that was associated with pain with activities of daily living and weight bearing, and felt that Mr. Santanna was completely and totally disabled; could no longer work for the railroad; should not be around heavy moving machinery, on uneven terrain or climb, and has limited ability to stand, walk or sit.

[1] Mr. Santara reported a gradual onset of knee pain that escalated in October 2011 after twice walking the full length of a 7800' long train that was in an "emergency application", with resultant excruciating knee pain, R > L.

[2] Mr. Santanna's last day worked was 12/9/11, after the railroad took him out after failing part of his annual physical exam (inability to fully squat or hop) in November.

Mr. Santanna is 5'11" tall and currently weighs 285 pounds, with a BMI of 39.7[3]. Dr. Haley's records noted Mr. Santanna's weight of 276-291 pounds in 2011 and 305 pounds in March 2012. Mr. Santana indicates a negative history for smoking, engaging in other physically demanding activities or being involved in motor vehicle accidents; and is unaware of any family history of knee osteoarthritis or arthritis.

Job Overview

Mr. Santanna last worked for CP Rail as a Conductor, based out of Taylor, PA. He has worked for the railroads since 1977, all in capacity of Conductor except for his initial work with the D & H as a Trackman:

CP Rail	1990-2011
NYSW	1988-1990
GTI	1982-1988
D & H	1977-1982

Since 1990, Mr. Santanna was based out of Binghamton NY or Taylor PA. Over Mr. Santanna's 30+ years, most of his Conductor work was in the yard, with some intermittent road jobs, until he was able to bid on and obtain a road job for his last two years with the railroad[4]. In Binghamton, two Conductors worked in the yard, while only one worked the Taylor yard.

Mr. Santanna worked varied shifts, working mostly days and evenings in the yards, and all hours on the road, where his trips involved one night stay overs, e.g. ride up to Saratoga from Binghamton on one day, stay over, and return the following day. On the road, Mr. Santanna alternated weeks of doing two or three weekly runs.

The duties of the Yard Conductor are to direct freight cars within the yard. Mr. Santanna worked both in-bound and out-bound cars at the Binghamton and Taylor yards. The Binghamton yard is bigger, with 19 yard, 2 main and 1 runner tracks, and is built like a bowl. Taylor has 6 yard, 2 main, 2 intermodal and 1 runner tracks and is on a hill. At Binghamton, Mr. Santanna was part of a 3-man crew with an Engineer and Brakeman; at Taylor he was part of a 2-man crew with his Engineer. He usually handled 2-3 trains per shift, or about 200-400 cars per day at Binghamton and 75-150 cars a day at Taylor. When on the road, Mr. Santanna was a part of a 2-man crew with his Engineer.

Mr. Santanna's daily job duties included:

- Riding cars
- Switching out cars / making up trains / kicking / shoving cars
- Throwing / aligning ground switches
- Pulling cutting levers
- Tying / releasing hand brakes
- Applying chocks to cars
- Coupling / uncoupling air hoses
- Assuring safety of vehicles at public crossings, as needed
- Communicating with the Engineer via hand held radio or passing hand signals

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[3] BMI's of 30 or greater are considered obese.

[4] Mr. Santanna found the road jobs easier on his knees, as they involved more train travel and less time standing and working in the yards. For example, on the usual Binghamton-Saratoga 11-12 hour run, the train stopped at 2-4 sidings, with each stop lasting 0.5 - 3 hours.

This work is regularly associated with:

- Standing and walking on various size ballast, uneven and sloped terrain
- Mounting / dismounting equipment
- Climbing up / down ladders
- Stepping and climbing onto/from cars
- Bending / stooping and squatting

Discussion of Specific Job Duties

The Yard Conductor performs many repeated daily cycles of the aforementioned tasks related to moving cars in and within the yard. While performing these brief and short cycle tasks repeatedly throughout the day, the Conductor regularly climbs on and off cars, rides alongside cars, walks on ballast as he walks the train(s), and bends and squats while performing car inspections and throwing switches. The Road Conductor performs all the same tasks, but in lesser frequencies.

Ride Cars within the Yard

Mr. Santanna estimates climbing onto 20-100 cars per day, first climbing onto the stirrup and then the ladder. When holding on for travel in the yard[5], Mr. Santanna stood upright, with his legs twisted to the sides as there was not enough space between the rungs and train for his feet to point forward.

Mount/Dismount Freight Cars

While switching and moving cars in the yard, applying/releasing hand brakes or performing necessary train operations, Mr. Santanna climbed up onto and stepped down from 20-100 cars per day. Stirrup heights were a minimum of 18 inches from the track and not always easy to access; their specific heights in relation to the ground varied with road conditions and the type of car. For very high stirrups that Mr. Santanna could not access, he often climbed up on an adjacent car and then climbed over to the adjacent car if he needed to do a specific task, e.g. apply a brake, to that car. From the stirrup, the Conductor then climbed onto the first ladder step, a distance that varied from 18-24 inches.

When getting on/off cars, the Conductor steps down onto leveled and/or sloped ballast surfaces, depending on where he is in the yard. Mr. Santanna indicated that stepping down onto sloped ground was a bigger issue on the road where the tracks were elevated and sloped for drainage.

Throw Switches

While moving cars in the yard to designated tracks, Mr. Santanna indicates usually throwing 100 - 150 switches a day (and up to 300 on some days), nearly all of them low short switches at both yards, and often throwing the same switch multiple times. When Mr. Santanna last worked, he indicated that Binghamton had only 1-3 high switches at the ends of the yard and Taylor had one. On the road, Mr. Santanna reported that most of the sidings had high switches. When throwing the low switches with short handle and 30-pound balls, Mr. Santanna assumed squat postures, while keeping one foot/leg on the dog catch or keeper, and using both arms to lift and pull the near ground level switch handle through a 180 degree arc. Mr. Santanna

[5] Depending on the distance to move cars, Mr. Santanna either rode on the cars or walked in the yard.

reported overall good switch maintenance and that repairs were usually made within a few days of reported issues.

Run Brake Tests

Mr. Santanna usually did two brake tests a day; these were done on outgoing cars in the yard, and for in and out going cars on the road. This involved the Conductor walking the full train length two times. While walking, the Conductor stops and inspects underneath each car; this involves bending over to check the brakes under each car[6]. The Binghamton Bowl Switch track length was 3,100-3,400 feet (about 6/10 of a mile) and could handle a maximum of 60 car lengths. Mr. Santanna estimated train lengths of 2,500-11,000 feet (0.5-2 miles) on the road, for trains made of 40-120 cars, and that running a brake test on a 75-100 car train took 1-1.5 hours, at a minimum. As needed, Mr. Santana also climbed up and over cars to check the brakes on the opposite side of the car.

Apply & Release Hand Brakes

Mr. Santanna estimates climbing up and down cars to apply and/or release hand brakes 25-50x per day in the yard, and applying hand brakes on each car in the Binghamton bowl. He climbed onto the first car of each train over the 19 tracks at the start and end of each shift (releasing the brake at start of the shift and applying at the end). On the road, Mr. Santanna estimates applying 20-40 brakes per day at the sidings, with the number corresponding with how many cars were picked up and/or dropped off.

While access to the brakes varied with each type of rail car, they all involved climbing and awkward reaches to access the lever or rotary style brakes, where Mr. Santanna used his upper body to pull himself up and over to the platform so that he could stand to reach the brake, after squatting or kneeling to reach this area- when maneuvering from the ladder and small platforms. He reported easier access to the grain hoppers and more difficulty accessing the gondolas, auto racks and tank cars.

Mr. Santanna always climbed on the cars to apply/release brakes and never used a brake stick, nor did he indicate that any ere available.

Couple & Uncouple Cars, Pull Cutting Lever / Open Knuckle & Align Draw Heads

Mr. Santanna estimates coupling 150-400 cars a day when working in the yard. While doing this, he could stood either upright or stooped, while reaching down to pull the cutting lever up with one hand and push up the 80-pound knuckle with the other hand, while applying medium-high force. In some cases, Mr. Santanna needed a second person to assist with this task. Similarly, Mr. Santanna walked along the train and uncoupled 150-400 cars a day; this required stooping to about knee level to release the cutting levers. While standing and stooped, Mr. Santana coupled about 50 air hoses a day.

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[6] If a brake problem was identified, the Conductor then needed to make a cut to set the car out, after first securing the remaining cars, which was followed by repeating the brake test for the entire train.

ERGONOMIC & BIOMECHANICAL DISCUSSION

There has been increased attention to the development of work-related injuries by health and safety professionals in the past twenty five years. Most of these injuries relate to a combination of wear and tear, overexertion, repeated exertions, cumulative stress and strain on particular body parts, e.g. joint, muscle, tendon, tendon sheath, or nerve. Many overuse injuries and occupational illnesses have been associated with the lower extremities because of their weight bearing characteristics and mechanical structure.[i]

Cumulative Trauma Disorders (CTD) refers to a category of physical signs and symptoms due to chronic musculoskeletal injuries, rather than to a single strain or sprain injury. According to Putz-Anderson, "In these cases, workers may be exposed to sources of job-related microtrauma for years and never recognize the role of [his/her work] in contributing to these disorders." Repeated exertions and motions affect the soft tissues, most commonly the nerves, tendons and tendon sheaths, and muscles of the upper extremities. OSHA uses the term work related musculoskeletal disorders (WRMDs) to refer to these disorders affecting the upper and lower extremities and spine. The literature refers to chronic work-related musculoskeletal disorders by many names: cumulative trauma disorders, repetitive strain injuries, repetitive trauma disorders, overuse syndromes, or regional musculoskeletal disorders.

In an ergonomics manual published by the Association of American Railroads,[ii] they stated that the likelihood of a person developing a CTD increases when a combination of risk factors (worker, job and environmental) are present; that some personal characteristics and limitations can make people more susceptible to CTDs; that work methods increase wear and tear on the body; and environmental conditions can contribute directly or indirectly to CTDs. They note that high repetition, awkward posture and high force are among the factors that can contribute to wear and tear on susceptible tendons, muscles and nerves; and that all tissues have a certain tolerance for stress. When stressors exceed the body's structural capacity, CTDs can develop. Occupational health clinicians and researchers also note these risk factors of excessive force or pressure, awkward and/or sustained postures, repeated motions, inadequate rest periods between physical exertions, exposure to vibration, extreme hot or cold conditions,[iii,iv,v,vi,vii,viii] and an increased CTD exposure risk when greater than one risk factor is present.

Lower Extremity Cumulative Trauma & Knee Osteoarthritis

Many overuse injuries and occupational illnesses have been associated with the lower extremities because of their weight bearing characteristics and mechanical structure. It is the job of the lower extremities to carry the weight of the body, to move the body from place to place, and help maintain balance and equilibrium.[ix] Repeated exposure to mechanical factors while performing various physically demanding work tasks can expose the knees to recurrent trauma. Muscles and ligaments surrounding the joints operate to maintain joint stability by actively responding to forces placed on the joint. When joints are exposed to external forces or loads, the muscles and ligaments must resist the resultant joint moment of force. Radin et al.[x] note that in addition to acute trauma which can trigger osteoarthritis, there is evidence that repetitive forces to the joints can lead to microfractures of the articular cartilage and subchondral bone, resulting in similar degenerative joint changes. With each new micro-injury and/or repeated joint loading, the cartilage and joints become stiffer, lose their ability to regain their full tensile strength, and makes the overlying cartilage more susceptible to injury. Greater loading forces on joint and tissue structures are considered excellent predictors of a task's injury potential.[xi]

Osteoarthritis is generally considered a part of the aging process[7] that occurs most frequently in mechanically overloaded joints; it is a degenerative condition of the joints that affects the articular cartilage and subchondral bone. Occupational medicine researchers[xii,xiii,xiv,xv,xvi,xvii,xviii,xix,xx] discuss multi-factorial causes of osteoarthritis (OA) and occupational knee disorders, as a result of these large weight bearing joints being loaded and exposed to mechanical overuse when performing heavy physical activity. OA is usually classified as primary or idiopathic when it develops in the absence of pre-disposing factors; secondary OA is usually the result of injury or specific mechanical injury to a joint.

- Chaffin and Andersson[xxi] cite recurrent trauma, joint instability, stress magnitude concentrations and mechanical factors as being important in the development of both primary and secondary OA.

- Mayer[xxii] and Kohatus[xxiii] cite chronic overuse related to occupation and long-term exposure to heavy physical activity as knee OA risk factors and higher exposure risks for osteoarthritis in physically demanding jobs.

- Peyron's[xxiv] literature review concluded that most epidemiologic studies point to a relationship between usage and development of OA.

- In discussing a multi-factorial etiology and relationship between heavy work and mechanical overuse, Vingard et al.[xxv] cite dynamic forces from instant stress on a joint that result in micro cartilage fractures which exceed the bone's shock absorbing capacity.

Occupational activities commonly cited in relation to persons who incur knee injuries include lifting, repeated bending while carrying heavy loads, squatting, kneeling, climbing and jumping. While the exact injury mechanism is not always identifiable or understood in relation to work factors themselves, there is evidence that work exposure may accelerate the degenerative process in persons with physically demanding jobs, e.g. firefighters, construction workers, coal miners, shipyard workers, carpenters, carpet installers, and concrete workers.[xxvi,xxvii,xxviii,,xxix]

- Andersson[xxx] notes various studies that show higher rates of cumulative knee OA in persons with a history of knee injury, occupational physical loading (15%) and obesity (10%), jobs requiring knee bending and at least a medium level of physical activity, and for men and women involved in physically demanding jobs (as noted in the NHANES study). He feels that the factors of static load, repeated trauma over long periods and unnatural use of the joints are likely to contribute to OA.

- Vignon, Valet and Rossignol[xxxi] found a high level of scientific evidence for a relationship between occupational activity, knee and hip OA; and cited contributory factors as high loads on the joint, body position, heavy lifting, climbing and jumping, although the precise nature of biomechanical stress was not clear.

- Schouten et al.[xxxii] found evidence for the support of occupational physical factors, activity and the occurrence of OA.

- Cooper et al.[xxxiii] found that prolonged or repeated knee bending is a knee OA risk factor and this risk may be greater in jobs that entail both knee bending and mechanical loading.

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[7] Mr. Santanna was only 54 years old when he reported the onset of increased knee pain and stopped working.

- McGillan & Nicholos'[xxxiv] study of miners found that work involving kneeling and/or squatting is causally associated with an increased risk of knee osteoarthritis and that lifting in conjunction with this posture can further increase the risk of OA.

- Jensen & Eenberg[xxxv] note occupation as a risk factor for knee disorders, in particular OA in workers whose work involved substantial kneeling or squatting.

- Drs. Subin and Brigham[xxxvi] reviewed the risk factor of climbing and the development of knee OA and of severe OA requiring total knee arthroplasty. They found greater odds ratios when workers were exposed to ≥ 2 hours climbing per day and climbing > 30x per day and > 1 year; and also refer to other studies that showed an increased risk associated with kneeling or squatting of 1 - 10 years, but no dose response relationship.

- Prior to the beginning of a 2008 case control study of individual and occupational risk factors for knee arthritis, Klubmann et al.[xxxvii] cited a multifaceted etiology to OA of the knees, which includes occupational work factors such as working in kneel or squat postures, lifting and carrying heavy weights. At study conclusion,[xxxviii] Klubmann et al. found that occupational and non-occupational risk factors play important roles in the etiology of knee OA in both men and women and that these risk factors "are either synergistic or additive, each with a graded relationship to the OA risk."

- A 2008 study by Seidler and Bolm-Audorff[xxxix] supported a dose-response relationship[8] between kneeling/squatting and symptomatic knee OA, with higher rates evidenced in occupations that involve both kneeling/squatting and heavy lifting/carrying.

The body prefers symmetry. When there is asymmetry, load forces are greatest on the side performing weight bearing or twisting motions that involve torque. Excessive stepping to heights at or above waist level results in asymmetric body postures. Symmetry is not usually possible when standing on uneven terrain or when performing rotary motions. Good footing is known to help provide operator stability and avoid the need for additional compensatory patterns;[xl] this is an issue for all rail workers who regularly stand and walk in train yards and industry sidings, on various size (mainline and walking ballast) and sloped ballast. Without equal or secure footing when standing or walking on uneven terrain or ballast, or when there is jolting train movement, symmetry is not always possible, subjecting the lower extremities to increased rotary forces when upper body movements are superimposed on this stance, requiring greater efforts by the rail worker to maintain good footing.

Andres[xli] notes that rail workers who walk on ballast have a tendency to develop lower extremity musculoskeletal disorders as they walk on ballast and experience slips, falls and trips, as they have a reduced ability to exert and maintain equal footing. When ground surfaces are further affected by adverse weather elements of mud, snow, ice, etc., this further increases rail workers' required efforts to maintain good footing because of reduced frictional co-efficients between the body and ground, further adding to poor worker footing that is necessary to provide stability.[xlii]

In a recent study by Wade, Redfern, Andres and Breloff[xliii] that was funded by the AAR, they (2010) found that gait biomechanics vary significantly between flat, hard and ballast surfaces, with further differences between walking on mainline and walking ballast, e.g. larger moment profiles, greater EMG and co-contraction activity, and a slower, more pronounced gait on the mainline or larger ballast. Further support for this is noted by the FRA (2008) that 35% of all reported injuries were associated with torso and lower extremity sprains and strains and by

[8] They noted a "doubling duration" at about 13,000 hours.

railroad managers that "improper ballast" was a contributing factor to railroad yard injuries, where the FRA (2001) felt that the "distribution of smaller 'walking' stone may help reduce railroad yard injures."[xliv] The authors feel that their findings support the FRA's contention that using walking ballast in all rail locations where regular walking is required would be a best practice to promote a positive safety climate and decrease lower extremity musculoskeletal demands on rail workers.

Ergonomic & Physical Demands of Conductor's Work

Mr. Santana worked mostly as a Yard Conductor for his 34 years with the railroad. This work involved near continuous standing and walking for the day or 90% of the day as a Yard Conductor and 40-50% of the time as a Road Conductor; walking on ballast in the yards alongside trains being inspected and between tracks, and walking on even, uneven and sloped ground/track surfaces. While performing the daily duties of a Conductor, Mr. Santana's knees were exposed to cumulative trauma risk factors in conjunction with repeated climbing up and down freight cars, balancing and supporting oneself while travelling on cars within the yards; stooping, crouching and squatting to apply force to throw low level switches and other routine rail yard tasks; and unequal force distributions on the lower extremities while walking on mostly mainline ballast. Over time, soft tissue and joint structures weaken from repeated microtrauma. When the cumulative effect of repetitive stress exceeds the physiologic limits of human tissue, CTD injury results.

Physical Demands

In a 1977 report authored by C. H. Lawshe[xlv] and developed by a Task Force represented by eight railroads entitled *Job Analysis Summary: Physical Demands and Environmental Conditions for the job of Trainman/Switchman,*" the physical demands of these crafts are described. Those pertaining to the lower extremities and spine for a Trainman/Switchman were identified as:

- Walking 75% of time for the average Trainman in his first 2-3 years
- Occasional lifting and carrying of maximal weight of 83 pounds;
- Occasional pushing of >100 pounds, e.g. adjust draw bars;
- Frequent pulling of >100 pounds, e.g. remove broken draw bars, set/release hand brakes and align switches;
- Very Heavy physical strength demands;
- Climbing, balancing, crouching, and stooping are present and important;
- Kneeling and crawling are present but not important;
- Exposure to extreme cold and heat, and wet conditions and an outdoor environment is present and important; exposure to vibration is present but not important

Ergonomic Injury-Risk Factors

Work Posture Issues

The Conductor regularly assumes stoop and crouch/squat positions when working at or below waist level, e.g. to access low level ground switches level. He mainly stoops when coupling/uncoupling cars, working at near waist level. At least moderate exposures also occur each time the Conductor flexes his knees to ascend up onto the first stirrup, or about 18 inches.

The Conductor stands and walks on the ballast throughout the day when making up trains and throwing switches. Mr. Santana estimated his time on the ground to be 75-90% of the day, in contrast to 40-50% of the time when on the road. When standing on uneven terrain, equal

planting of the feet is not possible, particularly when on mixed or large ballast. This can result in asymmetrical weight bearing and footing and in turn, in stress/strain and injury to lower extremity musculoskeletal structures because of non-neutral standing and weight bearing postures.

Mr. Santana indicated there was small ballast in only two areas of the Binghamton yard, and that in 1991, CP Rail replaced the existing ballast with "pea" stone to improve the walking conditions *only* between Tracks 6 & 7 and 7 and 8. Mr. Santanna stated that he complained several times to his supervisors and/or terminal managers regarding the mainline ballast throughout most of the yard and associated yard walking condition issues.

Mr. Santana indicated "normal amounts" of debris in the Binghamton yard, but increased debris when on the road, e.g. at Mohawk, that affected overall walking conditions, and lesser amounts at the Kenwood and Saratoga yards. In the yards, there were few places or opportunities for the Conductor to sit and rest the knees/legs.

Repetition & Task Duration Issues

Mr. Santana performed a lot of repeated short duration tasks (< 1 minute) throughout the day, in conjunction with sustained standing and walking in the yard. He climbed on and off cars intermittently throughout the day. This requires repeated knee flexion each time the Conductor steps up onto the stirrup and then to the ladder. He assumed flexed knee postures that involved up to 50% of normal range each time he stooped or crouched to throw ground level switches about 100 - 150 time a day or (or 12-18/hour or one every 3-5 minutes). Standing postures with stooping to work at near waist level was required to couple 150-400 cars a day. Mr. Santana climbed up and down cars to apply and release hand brakes 25-50x/day in the Binghamton yard

Force Issues

Mr. Santana exerted variable force levels with his body on a daily basis, with the amount of force required and exerted related to the condition of and access to the equipment. Throwing low short arm switches is associated with medium-high force efforts. For all types of switches and equipment, maintenance (e.g. proper oiling, removal of sand, etc.) affects the required force effort, with greater force efforts required for equipment that is not well maintained. This includes increased lower extremity static and dynamic force efforts to help stabilize the body while working with the upper body. When exiting cars throughout the day, stepping down onto uneven ground surfaces is also associated with unequal force distributions on the knees and lower extremity structures. Static loading forces on the knees and body are required to maintain one's posture. Greater lower body stabilizing forces that can stress the knees are required when standing on larger mainline ballast in contrast to walking ballast, uneven and sloped terrain.

Exposure to Vibration & the Cold

The body is subject to vibration when the Conductor stands and rides on cars, standing on stirrups or ladder rungs, or when the Conductor rides the Engineer in the locomotive. The Conductor works outdoors, where the ground is subject to all weather elements of rain, mud, snow, sleet and ice, all which can further increase the required force efforts to maintain one's footing, when there are decreased coefficients of friction.

As Mr. Santana worked the evening shift, lighting was an issue as not all tracks were lit. He carried a lantern to guide him throughout the yard and for his inspection work under each car. The Binghamton yard had lights on only the lead tracks or north and south ends of each track and there were no lights at Mohawk when he worked (there are now).

Musculoskeletal Research: National Academy of Medicine & OSHA

The National Academy of Sciences/National Research Council issued two extensive reports (1998 and 2001) with contributions by well-known professionals in the fields of orthopedic surgery, occupational medicine, public health, epidemiology, risk analysis, ergonomics and human factors: *Workshop of Work Related Musculoskeletal Disorders: Examining the Research Base* (August 1998)[xlvi] and *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities (2001).*[xlvii] This research found strong evidence for the presence of work-related risk factors and the development of musculoskeletal injuries. In its second report, the Council states:

the weight of the evidence justifies the identification of certain work-related risk factors for the occurrence of musculoskeletal disorders of the low back and upper extremities, and that the basic biology and biomechanics literatures provide evidence of plausible mechanism(s) for the association between musculoskeletal disorders and workplace physical exposures; and

that the weight of the evidence justifies the introduction of appropriate and selected interventions to reduce the risk of musculoskeletal disorders of the low back and upper extremities; and that these include, but are not confined to, the application of ergonomic principles to reduce physical and psychosocial stressors.[9]

In November 2000, the Occupational Safety Health Administration/OSHA issued its final ergonomics standard,[xlviii] the purpose being to "reduce the large number and severity of musculoskeletal disorders (MSDs) that are caused by occupational exposures to ergonomic risk factors on the job[10]. In developing its standard which was also supported by The American College of Occupational and Environmental Medicine, OSHA cited several well-known scientific reports. In the Introduction to its Standard, OSHA stated that, "more than enough evident exists to demonstrate the need for a final standard." While the standard was overturned shortly after its passage, its contents were similar to ergonomic policies and procedures that have been recommended by and advocated by health and safety professionals for the past decade[xlix], as well as in previous OSHA ergonomic program drafts and which have been demonstrated in other industries. The standard states that ergonomic programs should have the following elements:

- Management leadership and participation
- Hazard Identification and information
- Job hazard evaluation and control
- Training[11]
- Medical Management
- Program evaluation

[9] The NAM report indicates that that "to be effective, intervention programs should include employee involvement, employer commitment, and the development of integrated programs that address equipment design, work procedures and organizational characteristics."

[10] Much of the research OSHA relied upon was discussed on the previous pages of this report and the above National Academy of Sciences/National Research Council (1998) and NIOSH's (1997) scientific review of hundreds of peer-reviewed studies involving workers with MSDs.

[11] In 1992, the American Association of Railroads provided an Ergonomics Workshop whose objective was to "provide basic ergonomic skills and tools for improving safety and productivity." The course provided a thorough review of ergonomic applications and benefits for the railroad and railroad personnel. See next section for discussion of AAR and ergonomics awareness training.

The AAR & Ergonomics

The American Association of Railroads or AAR, the railroad trade organization, has been involved in ergonomics for almost 20 years. The AAR provides numerous education materials to its member railways. For example, in 1992, the AAR published its "Basic Ergonomics: Principles and Techniques" training program. This included the preparation of extensive ergonomics training materials that addressed low back pain and manual material handling, and cumulative trauma disorders, with respect to the railroad. The AAR indicates that the application of ergonomics requires a long-term continuous process, not a quick fix program and that this includes:

- Surveillance to monitor safety, health and performance
- Job analyses, to identify ergonomic opportunities
- Application of ergonomic principles to job design and re-design
- Participation of employees and management

Workshop topics included analysis of health and safety data, job design for worker size, slips and falls, low back pain and material handling, cumulative trauma disorders, working in hot and cold environments, and physical fatigue. Training materials included a manual and overheads.

While developing its own training and education programs for its members, the AAR also reviewed what types of ergonomics programs were being implemented throughout the country. In 1994, they reviewed ergonomic programs at heavy industrial corporations. As stated in the introduction to a report entitled "*Ergonomics Programs at Heavy, Industrial corporations,*" they note "to the extent that ergonomics programs or processes in railroad companies are similar to those summarized here, this document also serves to identify the process elements and stakeholders that might benefit from services provided by the AAR;" that this report was prepared for information purposes, and that it "does not identify or recognize, the existence of any safety hazards or potential safety hazards in the railroad industry."[i]

It should also be noted that in the early 1990's, the railroad industry as a whole was gaining insight into ergonomics and injury risk factors for its workforce. This was communicated to the individual railroads by the AAR and further evidenced by its development of ergonomic education programs, ergonomics/safety training materials and handbooks at other major railroads throughout the country in the early-mid 1990's.

D & H / CP Rail & Ergonomics

CP Rail appears to have a comprehensive safety program that addresses general industrial and rail safety issues, as noted in the following documents: *Safety & You and Safety Handbook, Engineering Pre-Test Part A year 2000, Engineering Services #1 Safety and You 2002 and 2003 Participant Guides, Engineering Services Annual Safety Training, Engineering Services USA Annual Safety Training 2004; and Additional Rules and Safety Instructions for Engineering Department Personnel, Track Car Operators, Train Dispatchers and Transportation Supervisors.* Ergonomics was not, however, identified in CP's safety handbooks:

- *CP Rail System Safety Handbook:* in this at least 230 page booklet (full document not reviewed), the Table of Contents indicates sections on lifting & carrying and material handling (pages 160-166), but none on ergonomics or related health & safety topics.
- *CP Rail System Additional Rules and Safety Instructions for Engineering Department Personnel, Track Car Operators, Train Dispatchers and Transportation Supervisors* (effective 4/10/94): ergonomics is not a topic in this booklet.

In CP's annual safety training programs, ergonomics was identified:

- *Annual Safety Training/#1 Safety and You* (1998): this training includes an "Ergonomics Body Care Refresher" section (pages 13-14) where the headers are body facts, common causes of discomfort & injuries, ergonomics & body mechanics and the importance of stretching."
- *Engineering Pre-Test Part A* (2000): no questions on ergonomics, reporting of injuries or musculoskeletal discomfort; (1) question related to the steps of proper lifting.
- *Safety and You Participant Guide* (2000): Module 2 is a 60 minute *Hazard Assessment Awareness*. On the *Hazard Assessment Checklist* (pages 8-9, 16-17), it identifies what is a health hazard, e.g. "a work design hazard/ergonomic hazard, chemical, biological or physical agent hazard (page 2), ergonomic issues: awkward posture, repetition, force, grip size, sedentary position, vibration, bending & twisting, extended reach, overhead reach, overexertion, manual material handling and other"; and a separate section on material handling issues; provides rating systems related to the probability and severity of injury risk (page 11); and the roles/responsibilities of foremen, supervisors, managers, health &safety committee representatives. Part of the Job Briefing process includes leading employees "through a warm-up [stretch] to prepare for injury-free work (page 3 of Module 3).
- *Safety and You Participant Guide* (2002): in the section on *Risk Management,* identifies what a health hazard can be ("any agent, situation or condition that can cause an occupational illness and includes ....work design and stressors", page 8). On the *Hazard Assessment Check List* (pages 14-15), it identifies ergonomic issues: awkward posture, repetition, force, grip size, sedentary position, vibration, bending & twisting, extended reach, overhead reach, overexertion, manual material handling and other; and a separate section on material handling issues.
- *Safety and You Participant Guide* (2003): has a 9-page section entitled *Ergonomics Awareness, Overexertion and Tissue Damage*, where the total 60 minute module activity headings include ergonomics definition review, musculoskeletal injury (MSI) definition, MSI graph and personal injury trends, taking responsibility/our objective, overexertion and tissue fatigue, prevention of injuries/situation awareness, activity/group case study, and a link to physical fitness/physical activity.

These training programs, from at least 1998 on, indicate CP's awareness of ergonomics and inclusion in its *Hazard Assessment Checklist.* Mr. Santana recalls having daily safety briefings with his Engineer and/or Brakeman, and yearly "Rules classes" that reviewed general safely and lifting techniques, with some mention of the word ergonomics and no recollection of early reporting. Mr. Santana recalls regularly reporting safety issues to terminal managers, both verbally and turning in safety cards regarding yard ground and lighting conditions; and being told to "stretch before each shift", but not seeing any posters for same in the break room, and that he "couldn't take the time to do this because he needed to get the work done."

CP Rail had corporate ergonomists for several years.[12] In the deposition of Dr. Weames, a former Canadian Pacific Senior Ergonomist (approximately 1998-2002), he (2010) stated that his duties were to advise various departments on ergonomics, serve on various health and safety committees, e.g. the Hazard Prevention Committee, develop training materials, investigate field requests for health and safety, and review new equipment purchases for ergonomics. In 2000, Dr. Weames developed an ergonomics awareness training program and

[12] At a minimum, there was an ergonomist prior to Dr. Weames (2010) and following him, e.g. Ms. Krista Mcintosh.

assessment tool which included a 1-hour training program and accompanying written document.[13] In his deposition, Dr. Weames referred to CTD's and RSI as "non-acute" injuries and feels that the term "non-acute" injuries is "a more modern scientifically correct term used by NIOSH, OSHA and the FRA."[14] He indicated that CP Rail has a computer program (the MIDAS System) to report injuries by body part for FRA reporting and trend analysis; and that the recorded injuries include only date-certain injuries and not "non-acute" injuries[15].

Dr. Weames indicated that he did hazard prevention on the Canadian side and they had an Engineering Ergonomics Strategy Process (pages 83-85 of his deposition) that was a guiding document for CP's Engineering Services Department and Internal Health & Safety Audits, where "ergonomics was a line item."[16] He also referred to a document entitled *Recommended Practices* from which these best practices were supposedly included in the Ergonomics Awareness Training, and *Riser Program* that is reportedly in the Safety Rule Book, a program "for front line employees to look at anything wrong with the tools and equipment."[17] Dr. Weames also discussed CP's use of ErgoRisk, an outside ergonomics consulting company[18]. From this preliminary review of CP's awareness of ergonomics, it appears that the railroad had at least a working knowledge with respect to hazard awareness and risk factor identification. How this knowledge was utilized and/or applied to the jobs and work which Mr. Santana did is unclear, and the training information reviewed to date does not discuss early warning signs or medical management issues.

Conclusion

Mr. Santana is a 56-year old man who worked for CP Rail and its predecessors for 34 years, mostly in capacity of Yard Conductor. Mr. Santana did not sustain any date certain injury and rather, became aware of progressive knee pain earlier in 2011. He last worked in December 2011 when he could no longer tolerate the physical job demands because of knee pain. Dr. Malloy noted that Mr. Santanna worked for the railroad for 35 years doing heavy and strenuous work duties, and that his severe degenerative/knee osteoarthritis was a limiting work factor and that he was permanently disabled from work.

This Ergonomist finds that Mr. Santana's job duties as Conductor exposed him on a daily basis to musculoskeletal injury risk factors that adversely affect the knees and have been associated in the literature with the development of degenerative joint disease and lower extremity cumulative trauma. Mr. Santana's work as a Conductor involved sustained stand and walk on ballast; repeated stoop, squat, and crouch intermittently throughout the day while completing routine rail yard tasks to move cars within the yard; and climbing on and off cars, with high first steps ups to

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[13] These programs appear to be those previously listed (See page 21) for at least the year 2000.

[14] This ergonomist agrees that CTD's are usually non-acute, but that this is *not* the descriptor used for this class of injuries that represent injuries which result from cumulative trauma or overuse.

[15] Recording only the date-certain injuries results in no trend analysis for cumulative trauma and other work-related musculoskeletal injuries that are of concern to ergonomists in developing pro-active injury prevention programs.

[16] This is assumed to be in the *Hazard Assessment Checklist;* if there is another audit that was used, no documentation of same has been reviewed.

[17] Neither of these programs or documents have been reviewed.

[18] It is also unclear at this time what ErgoRisk's role was in CP Rail's ergonomic program. In reviewing their website (www.ergorisk.com), one of their services is Education/Awareness and another is Manage Discomfort. Under the latter, program services more specifically include a section on Manage Discomfort and Early Intervention, where its states "MSI's [musculoskeletal injuries] often cannot be pinpointed to a single cause. The goal must be to avoid and/or manage all injuries that affect the individual and their ability to perform their job, regardless of whether causes were primarily work or non-work related".

the stirrups that involves pressure on the knees, prior to climbing ladders up onto the cars. Mr. Santana assumed these varied low level work postures in conjunction with standing and walking on varied ground surfaces, where he could not always assume equal or symmetrical footing, which is very important to obtaining lower body stability as needed while the upper body performs exertional work tasks such as throwing switches, coupling and uncoupling cars, or applying hand brakes, adversely and cumulatively affects lower body support structures.

CP Rail developed ergonomics training program around 1998, indicating its awareness of ergonomics, which it included on its Hazard Assessment Checklist. It is noted, however, that none of the materials reviewed indicated ergonomics was included in CP's safety handbooks, that CP Rail had a medical management component to its ergonomics program, and the importance of early symptom reporting. While CP Rail discussed exercise and stretching programs, this was not something that was done by Mr. Santanna or others in his work groups. In the early 1990's, CP Rail replaced some of the ballast in the Binghamton yard with small ballast. However, this was done in only two areas, improving the walking conditions for the Conductor in only the Track 6,7 and 8 location, while Mr. Santanna regularly walked and worked in the entire yard where mainline ballast remained.

While now 56 years old, Mr. Santana was not of advanced age when he began experiencing knee problems in 2011 or at age 54. His BMI of 39.7 is noted and this is considered another risk factor for degenerative arthritis of the knees, in addition to work exposure factors for loading on the knees. This Ergonomics Consultant believes that based upon my analysis of Mr. Santana's work, prior site inspections for other Conductors, my over 25 years of ergonomics experience and a review of the literature, that within a reasonable degree of ergonomic certainty, Mr. Santana's 34 years work as a Conductor exposed his knees to degenerative joint disease risk factors, which at a minimum, accelerated the degenerative process of knee osteoarthritis in these weight bearing joints.

Should other materials become available after submission of this report, this consultant reserves her right to amend this report.

Sincerely,

Ellen Rader Smith, MA, OTR, CVE

Ellen Rader Smith, MA, OTR, CVE, CPE
Licensed Occupational Therapist, Certified Professional Ergonomist & Certified Vocational Evaluator

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